

Maternal mortality in the past and its relevance to developing countries today¹⁻³

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ABSTRACT High maternal mortality was a feature of the Western world from the mid-19th century, when reliable record keeping commenced, to the mid-1930s. During this time, maternal mortality rates tended to remain on a high plateau, although there was wide disparity between countries in the height of the plateau. From ≈1937, maternal mortality rates began to decline everywhere, and within 20 y, the intercountry differences had almost disappeared. The decline in maternal mortality rates was so dramatic that current rates for developed countries are between one-fortieth and one-fiftieth of the rates that prevailed 60 y ago. In this paper, the reasons for the high mortality before 1937 and its decline since that date are discussed. It is suggested that the main determinant of maternal mortality was the overall standard of maternal care provided by birth attendants. Poverty and associated malnutrition played little part in determining the rate of maternal mortality. This view is supported by much evidence, including the fact that, unlike for infant mortality rates, maternal mortality rates tended to be higher in the upper than in the lower social classes. The potential relevance of these findings to developing countries is discussed. *Am J Clin Nutr* 2000;72(suppl):241S–6S.

KEY WORDS Maternal mortality, developing countries, history, midwives, infant mortality, nutrition

INTRODUCTION

The extent to which lessons can be learned from history (or the study of history) justified on practical or utilitarian grounds is questionable. Whether it is the history of medicine, politics, war, or anything else, it is dangerous to assume that the determinants of events in the past will operate in the same way in the present. If the butterfly of chaos theory flaps its wings in different places at different times, the results are never the same twice. Nevertheless, a review of the history of maternal mortality rates may elicit some questions and even suggest a few answers to the question of whether anemia control does, or can, reduce maternal mortality.

HISTORICAL TREND IN MATERNAL MORTALITY RATES

The trend in maternal mortality rates in England and Wales between 1880 and 1980 was such that the rate of maternal mortality remained on a high plateau through the mid-1930s, after which there was an abrupt and steep decline (**Figure 1**). This pat-

tern seemed so extraordinary that there were, initially, suspicions that the data were wrong or that an artifact had been mapped as a result of changes in the method of recording maternal deaths. After it was established that this was not the case (4–6), 3 major questions arose. First, was this pattern of maternal mortality peculiar to Britain or was it similar to that seen in other countries? Second, why did maternal mortality rates remain on a high plateau, albeit with spikes and troughs, from the 1850s to the mid-1930s although overall mortality, infant mortality, and mortality due to infectious diseases had started to decline by ≈1890–1900 (7)? These well-known demographic transitions are confidently attributed to a general rise in the standard of living emerging from better hygiene, better housing, better nutrition, and better general health, and are not accredited to medical care. If the above is true, why had these very factors failed to reduce maternal mortality rates between 1900 and 1935? Third, what caused the abrupt change in the maternal mortality rate in the mid-1930s with the subsequent steep decline that continued at almost exactly the same rate for the next 50 y? This question is important because, unlike disease-specific mortality rates, no other mortality rates showed such a profound decline in the second half of the 20th century. The risk of women dying in childbirth in the 1920s and 1930s was still as high as it had been just after Queen Victoria came to the throne in the 1850s. Today, however, the risk of women in England and Wales dying is between 40 and 50 times lower than it was 60 y ago.

The first question can be answered by comparing maternal mortality rates in the United States, England and Wales, and Sweden (**Figure 2**). In all 3 settings, maternal mortality rates tended to remain on a high plateau and at very much the same level until the end of the 19th century. In Britain as well as in France, Belgium, Australia, and New Zealand, the plateau continued with only a slight decline to a lower mortality level through the first 3 decades of the 20th century. There were, however, some striking differences between the pattern seen in the United States and in the northwestern European countries, ie, Sweden (**Figure 2**), the Netherlands, and Denmark (6).

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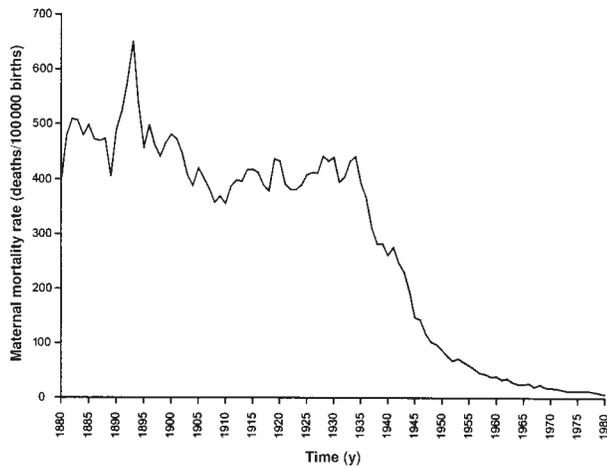


FIGURE 1. Annual maternal mortality rates in England and Wales, 1880–1980. Data from references 1–3.

There are few reliable data on maternal mortality rates in the United States before 1915, but thereafter, the United States had the highest rates of maternal mortality of any developed country (6). The data, however, need to be interpreted with caution for 2 reasons. First, the data were based on the expanding death registration area, ie, a limited number of states only, until 1933. Second, the criteria used to define a maternal death in the United States differed from those used in Britain. In Britain, deaths that would have been excluded as indirect maternal deaths (eg, influenza in pregnancy), were included in the US published data. In 1935, a well-designed survey by Elizabeth Tandy (10) of the Children's Bureau showed that of the number of deaths in the United States exceeding the number in Britain, one-half were due to differences in the classification of deaths or to the methods of data collection, whereas about one-half were real.

Puerperal fever and antisepsis

To understand the trends in the rates of maternal mortality in the countries of northwestern Europe, which were consistently much lower than elsewhere, a comment is needed on puerperal fever. This fever was the most common cause of maternal mortality before the mid-1930s, accounting for $\geq 40\%$ of all maternal deaths (6, 11).

Contrary to perceived wisdom, Semmelweis's work between 1847 and 1860 on the use of antisepsis to prevent puerperal fever had virtually no effect on deaths from puerperal fever in any country. Around 1880, Listerian antisepsis was gradually introduced into obstetrics, which greatly reduced the maternal mortality rate in maternity hospitals (6). Hospital deliveries, however, were so few that national maternal mortality rates were only reduced if antisepsis was used both extensively and properly in home deliveries.

From ≈ 1890 to 1900, there was a marked decline in maternal mortality rates in the countries of northwestern Europe. This decline in maternal mortality rates leveled out by ≈ 1910 , but at a much lower level than that for Britain or the United States. Although only data for Sweden are shown in Figure 2, the same low levels occurred in Norway, Denmark, and the

Netherlands, where there was a long tradition of home deliveries by well-trained and well-supervised midwives who conscientiously used antiseptic techniques from the time they were introduced. There was also a tradition of minimum surgical interference in home and hospital deliveries in northwestern Europe (6, 12).

Maternal mortality, home deliveries, and midwives

Historical data show that maternal mortality rates were lowest for home deliveries undertaken by trained and supervised midwives with no exceptions. Two examples from a wide range of evidence are presented below (6).

The rural nurse midwives of the Queen's Institute of Nursing, which was an organization of highly trained and supervised midwives in England and Wales, kept meticulous records on all maternal deaths occurring at home or after transfer to a hospital. This organization was particularly active between the 1920s and 1940s and achieved very low rates of maternal mortality similar to, if not better than, the rates achieved in the northwestern European countries.

Similar low levels of maternal mortality were achieved during the 1920s and 1930s in the United States by a remarkable service in the history of maternal care that was founded by Mary Breckinridge. Midwives in the Kentucky Frontier Nursing Service traveled on horseback to assist with deliveries, which were all at home in a poor rural farming community with low living standards. Despite the poverty, maternal mortality rates were ≈ 10 times lower than those in the nearby city of Lexington and the United States as a whole (Table 1) (6).

High maternal mortality due to unnecessary interference

In contrast with the above findings, maternal mortality rates were very high in countries, states, regions, or areas where most deliveries were performed by physicians, especially in the hospital. Maternal mortality rates were also high when maximum surgical interference in normal or potentially normal labors was encouraged or advocated. A leading American obstetrician in the 1920s, Joseph Bolivar DeLee (13, 14), wrote a paper entitled "The

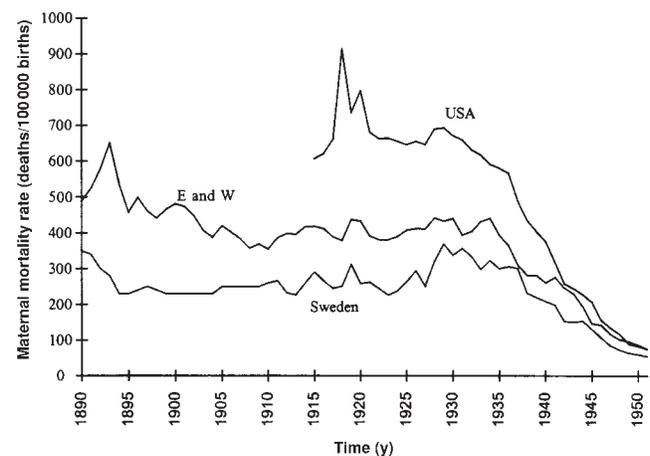


FIGURE 2. Annual maternal mortality rates in the United States, England and Wales (E and W), and Sweden, 1890–1950. Data from references 1–3, 8, 9.

TABLE 1

Maternal mortality rates during deliveries undertaken by the Kentucky Frontier Nursing Service, 1925–1937, compared with maternal mortality rates in other local and general populations of the United States in the same period¹

Population	Maternal mortality rate (deaths/100 000 births)
Women delivered by the Kentucky Frontier Nursing Service	60–70
White women of Kentucky	440–530
White women delivered by physicians in hospitals in the city of Lexington, KY	800–900
United States	
Total	560–700
White	510–630
Nonwhite	900–1200

¹From reference 6.

prophylactic forceps operation” in which he advocated that procedures for ordinary deliveries be changed to include anesthetizing every patient in the second stage of labor, delivering the baby with forceps, and manually removing the placenta using the “shoehorn maneuver.” His advice was heeded by many obstetricians and horrendous examples of iatrogenic mortality resulted. Another example, from Britain, was the widespread use of chloroform and forceps by general practitioners in uncomplicated deliveries between ≈1870 and the 1940s. This was described by one observer as a tendency a “little short of murder” (15) and accounted for many unnecessary deaths.

Maternal mortality and social class

Another unexpected finding related to maternal mortality, which was the basis for the second question raised at the beginning of this paper, was the inverse relation between maternal mortality rates and social class. Here the evidence comes almost entirely from Britain. Infant mortality is known to be strongly related to social class; the highest rates are found among the working classes, whereas the lowest rates are among the professionals. From at least the 1830s, however, the risk of dying in childbirth was higher in social classes I and II (the upper and professional classes, respectively) than it was in social classes IV and V (the skilled and unskilled laborers, respectively). An example of this is shown in **Table 2**, which gives data for 1930–1932 (16). The only plausible explanation for this social class difference is that the upper classes were more often delivered by physicians and, therefore, more likely to suffer unnecessary interference, whereas the lower classes were delivered by midwives, almost all of whom were trained by 1930–1932.

Causes of decline in maternal mortality after the mid-1930s

To answer the third question pertaining to the reason for the sudden decline in maternal mortality rates in the 1930s, it is necessary to look at changes in obstetric care. The initial impetus for the decline in maternal mortality rates was the introduction of sulfonamides, which were extremely effective against strains of *Streptococcus pyogenes* (the β -hemolytic streptococcus, Lancefield group A), which was the cause of most deaths of puerperal fever (6, 11) as shown in **Figure 3**. Other factors that contributed to the reduction in maternal mortality rates were introduced gradually. They included the use of ergometrine, blood transfu-

sions, and penicillin; better training; better anesthesia; improved organization of obstetric services; less interference in normal labors; and the decline in virulence of the streptococcus.

The decline in maternal mortality occurred at very much the same rate throughout the developed world. In 1930, differences in maternal mortality rates between countries were large: rates ranged from 250 deaths/100 000 births in the Netherlands to ≈700 deaths/100 000 births in the United States (**Figure 4**). By 1950, the rates in all countries were similar and by 1960 they were almost the same, ≈60/100 000 births. This convergence of maternal mortality rates throughout the developed world was an accomplishment that even the most optimistic obstetrician of the 1930s would not have thought to be possible within the span of 15–20 y.

The profound changes in the underlying causes of maternal mortality that accompanied the decline in maternal mortality rates in England and Wales are shown in **Table 3**. Puerperal fever went from being the main cause of maternal deaths in the 1870s to being a subordinate cause by the 1970s. Hypertensive disease (previously referred to as toxemia and eclampsia, or puerperal convulsions) moved from being the third most prevalent cause of maternal deaths in the 1870s to the number one cause in the 1970s, and deaths from hemorrhage (antepartum and postpartum) moved from being the second most prevalent cause in the 1870s to the sixth most prevalent cause in the 1970s. Although there may be differences in detail, it is probably safe to say that in developing countries with high rates of maternal mortality today, the rank order of causes is reasonably similar to that in Britain in the 1870s. If this is the case (4–6), it is a matter of great significance because it suggests that measures taken to reduce maternal mortality in the developed world ≈50 y ago may be the measures that would work best today in countries or regions with high rates of maternal mortality.

The profound decline in maternal mortality rates since World War II has been completely dependent on accurate data for both the number and causes of maternal deaths. In the late 1940s, which were the early years of the National Health Service, the British Ministry of Health introduced the system of confidential inquiries into the recording of maternal deaths, and every maternal death was subject to the most intense, but confidential, inquiry. It was perhaps the first official example of what has become known as a clinical audit. It is impossible to know what would have happened without this system of continuous audit, but the reports certainly

TABLE 2

Maternal mortality rates in England and Wales, 1930–1932¹

Causes	Social class ²			
	I and II	III	IV	V
	(deaths/100 000 births)			
All	444	411	416	389
Abortion	50	56	56	57
Puerperal fever	145	133	121	116
Hemorrhage	50	44	48	60
Toxemia	81	81	84	68

¹From reference 15.

²I, professional, middle, and upper classes; II, intermediate, comprising elements of I and III; III, skilled laborer; IV, intermediate, comprising elements of III and V; and V, unskilled laborer.

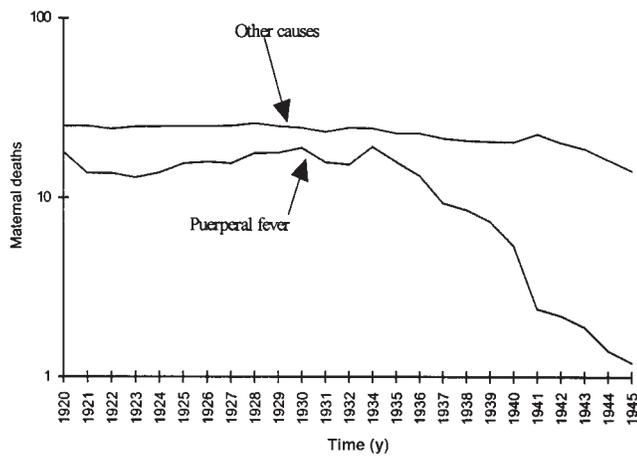


FIGURE 3. Annual maternal mortality rates attributable to puerperal fever and to all other causes (logarithmic scale), in England and Wales, 1920–1945. Data from reference 6.

give the impression that they identified the avoidable maternal deaths and led to ways of preventing such deaths.

NUTRITION AND MATERNAL MORTALITY

The significance of the features described in the above section suggest that there were 3 main determinants, but not necessarily causes, of maternal mortality in the past: the social and economic status of birthing women, the standard of obstetric care, and the virulence of streptococcus. Streptococcal virulence is an immensely complex subject that is not directly related to the topic of anemia and maternal mortality and will not be discussed here.

It is not known whether maternal mortality rates were high in the past primarily because the health of women was impaired, especially in terms of nutrition and anemia, or because of the standard of maternal care. It does not appear that there were any surveys on anemia in populations of expectant mothers before the 1930s and, even if there were, the accuracy of the measurements would be questionable because of the assessment techniques available at that time. There are, however, copious data on maternal mortality rates in poverty-stricken populations, in whom it is reasonable to assume that malnutrition was prevalent, and some physicians believed malnutrition was the underlying cause of high maternal mortality. For example, a medical officer of health in the 1930s said, with a touch of exasperation, that what was needed in South Wales (an area well known for having high maternal mortality) was a herd of cows and not a herd of obstetricians (19). Although a memorable remark, it is likely that he was wrong.

There is overwhelming evidence that social and economic conditions were very weak determinants of the levels of maternal mortality, whereas the standard of obstetric care was a very strong determinant. In situations in which nutritional status is so low that it approaches starvation, however, this may not be true. Under the conditions of poverty and associated malnutrition that were seen in parts of developed countries in the 19th and first half of the 20th century, it was care at parturition and not malnutrition and other concomitants of poverty that determined the level of maternal mortality. Although it can be argued that social

status and standards of maternal care were not wholly independent variables, because the rich could buy what they thought was the best maternal care and the poor could not, the reduction in maternal mortality in the past was generally independent of the economic status of the mothers. This is exemplified in the following 2 cases.

The industrial town of Rochdale in northwestern England had, in the early 1930s, the unenviable distinction of having the highest rate of maternal mortality in the country. Most of the population was poor, deprived, and malnourished. Rochdale also had an appalling standard of maternal care. In 1930, an exceptionally vigorous medical officer of health was appointed who totally reformed maternal care in Rochdale. Although there was no change in social conditions, maternal mortality rates decreased within a few years from 900/100 000 births (compared with 400–500 maternal deaths in England as a whole) to 170 maternal deaths and this low rate was sustained (15).

The second example comes from the United States, where a religious group in the state of Indiana, called the Faith Assembly, was investigated in the early 1980s. This sect consisted of well-nourished, middle-class, white citizens who had ordinary middle-class jobs. Their religion, however, led them to reject all forms of orthodox medicine, including the services of obstetricians and midwives. Maternal care consisted of prayer and delivery by family or friends. Maternal mortality in this group was 872/100 000 births compared with 9/100 000 for Indiana as a whole, a rate that was 92 times higher (95% CI: 19, 280) than that for the remainder of Indiana (20).

High and low rates of maternal mortality have never corresponded to changes in economic conditions (6). Most notably, US maternal mortality rates declined steadily from the beginning of—and throughout—the great depression of the 1930s (Figure 2).

CONCLUSIONS

In developed countries until the mid-1930s, maternal mortality rates were high. The major determinants of the high levels of maternal mortality were the standard of care at delivery and the virulence of *Streptococcus pyogenes*, which caused almost all deaths from puerperal fever. It was certainly true that before

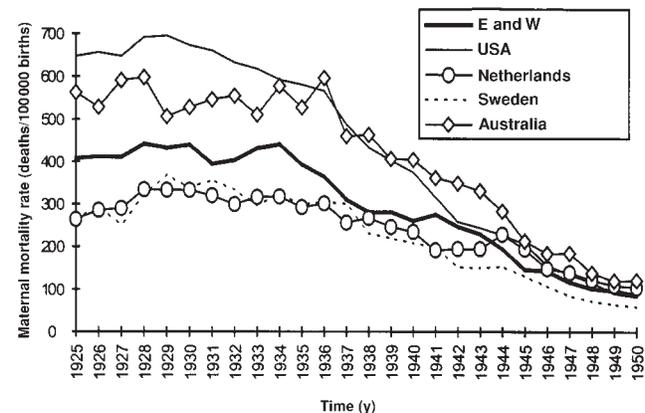


FIGURE 4. Annual maternal mortality rates in the United States, Australia, England and Wales (E and W), Sweden, and the Netherlands, 1925–1950. Data from reference 6.

TABLE 3

Total maternal deaths and percentage of maternal deaths in England and Wales by cause in 1872–1876 and in 1976–1981

Cause of death	%
1872–1876 (<i>n</i> = 23 051) ¹	
Puerperal fever	55.5
Hemorrhage ²	21.0
Puerperal convulsions	11.6
Miscarriage and abortion	4.0
Puerperal mania	2.5
Phlegmasia dolens ³	2.0
Retained placenta	1.5
Extrauterine foetation	0.2
Other	0.8
1976–1981 (<i>n</i> = 393) ⁴	
Hypertensive diseases	20.4
Pulmonary embolism	13.0
Ectopic pregnancy	11.4
Amniotic fluid embolism	10.2
Abortion	8.0
Hemorrhage	8.0
Puerperal fever	4.6
Ruptured uterus	2.2
Other	9.7

¹From reference 17.

²Recorded separately as hemorrhage and placenta previa.

³Interpreted as deep vein thrombosis and sudden death.

⁴From reference 18.

1937—and probably thereafter—malnutrition associated with poverty was a surprisingly minor determinant of levels of maternal mortality. High maternal mortality was substantially reduced only by providing high-quality maternal care by the standards of the time, not by improving the diet.

The sudden and dramatic decline in maternal mortality rates, which occurred after 1937, took place in all developed countries and eliminated the previously wide country-level differences in national mortality rates. The main factors that led to this decline seem to have been successive improvements in maternal care rather than higher standards of living. As a result of this decline in maternal mortality in developed countries, there is now no mortality for which there is a greater disparity between the developed and the developing world than the disparity in maternal mortality rates.

Interventions to reduce maternal mortality rates are likely to be much more effective if the underlying causes are known. This is particularly true when the underlying causes vary in extent,

DISCUSSION

Dr Ladipo: I was very impressed by your graph on maternal mortality from Britain and one Nordic country. One thing that struck me was that most of the natural decline in maternal mortality was after 1940, which coincided with the introduction of the National Health Service, when every individual in the United Kingdom had access to good care. In addition, in a welfare state, people may have been disadvantaged or unemployed, but the fact that they had reasonable income from the government meant that at least their level of nutrition would be within acceptable limits. Other factors that were more important for the

importance, or both, among developing countries. For this reason and despite the practical difficulties in doing so, it is important to assess attributable risk of maternal mortality in developing countries. In other words, it is important to identify the causes of maternal mortality whenever possible and to try to estimate the degree of certainty in the data. 

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sharp decline in maternal mortality were the use of antibiotics, availability of blood transfusion, and reduction in the high-risk pregnancies in the United Kingdom—notably teenage pregnancy and grand multiparity. Contraceptive use and acceptance by the wider population increased over time, particularly after the 1930s, and the role of contraception in that graphic change should not be overlooked in the discussion. The availability of contraception and improved health care services that were due to the National Health Service improved blood transfusion services and access to operative delivery and may have made a contribution to that reduction.

Dr Loudon: The beginning of the sudden improvement in maternal mortality was in 1937 (Figure 1). In the first few years, it was almost entirely due to the introduction of sulfonamides and later penicillin, and this applied to other countries as well. If the decline is plotted on a logarithmic scale, you get a straight line. Richard Doll (personal communication, 1993) remarked that this showed that the decline was not due to one factor but to many. The factors that may have been responsible were, first, sulfonamide and penicillin for infection; second, ergometrine use to reduce postpartum hemorrhage; third, universal blood transfusion; and fourth, much better cooperation and better medical education and so on.

What is interesting was that although the decline was partly due to the National Health Service, the fall occurred at the same rate in almost every country in the world. Figure 4 shows a huge disparity in maternal mortality rates among the United States, Australia, England and Wales, and the Netherlands before 1937, but after that it converges. By 1946, maternal mortality in these countries was separated by a whisker. There were ≈ 60 deaths for every 100 000 births and every country congratulated itself on its obstetric services. The United States said “this was a triumph of capitalism and modern medicine.” Australia said, “We Australians have always been the best.” Britain said, “It is the National Health Service.” Sweden and the Netherlands said, “It is our marvelous service.” Maybe each was right, but you can produce your own explanation. The disparity disappears almost completely by 1960 and has continued to today, where only a hairbreadth’s difference in maternal mortality rates exists among these countries.

Dr Ladipo: You talked about the pattern from 1850 onwards. What happened before 1850?

Dr Loudon: The important work was by Wrigley and Schofield, who wrote a population history of England [Wrigley EA, Schofield RS. *The population history of England. A reconstruction.* Cambridge: Cambridge University Press, 1981]. They found maternal mortality rates were certainly higher at ≈ 400 – 500 per 100 000 births throughout the 19th century. It was a bit higher at the beginning of the 19th century and was up to perhaps 1000 per 100 000 births in the early part of the 18th century. I have a graph in my book [Loudon I. *Death in*

childbirth. Oxford: Clarendon Press, 1992] that shows maternal mortality stretching back in history and, as you go back, it goes up very slightly and then we lose track because there really are no data as yet. Nevertheless, a dramatic fall in maternal mortality did not occur until 1937. A more dramatic fall was observed for Sweden, but that is another issue.

There is one recent and absolutely fascinating fact that does not affect maternal mortality at all, but it affects the topic we are talking about today. If you trace back infant mortality divided into neonatal and postneonatal mortality right through the 19th century, postneonatal mortality rates were much higher than neonatal rates, and that continued into the 20th century. Then, both mortality rates declined, but the neonatal rate went down more slowly than the postneonatal rate, as expected. The crossover point was ≈ 1950 , after which neonatal mortality was higher than postneonatal. It has recently been discovered that for reasons that none of us can fathom, between 1700 and 1750 neonatal mortality was higher than postneonatal mortality. After this time, both mortality rates suddenly came down, crossed over, and adopted the position described above for the next 150 y. This is purely a point of academic fascination, discovered by Professor Wrigley. I do not know the explanation, and we have discussed it back and forth. To come back to your original question, there was a slight fall in maternal mortality rates through the 18th century as far as we know. Indirect work, including Wrigley and Schofield’s brilliant work on parish records, has confirmed that there was not much of a fall in maternal mortality rates then in the United Kingdom. We do not know what happened in other countries except in Sweden where there was a profound fall.

Dr Maine: Are there situations in maternal mortality where each attributable and relative risk might have advantages?

Dr Loudon: As far as there is any analogy—and a very slight analogy may exist between historical work and modern work in the developing world—my feeling is that trying to get the best figures you can on attributable risk is essential, but you must recognize that it is an extremely difficult thing to do. You have to try to estimate the range of error in the data that you get, but without at least trying to do so I think you are hamstrung in trying to intervene.